Measurement and Characterization of Gelbstoff Optical Properties as a Water Mass Tracer in Coastal Regions

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LONG-TERM GOAL

To use the optical properties of dissolved organic matter as a tracer of small scale physical mixing processes.

OBJECTIVES

To assess the effects of biological, physical and chemical processes on CDOM concentrations and optical properties in coastal areas and determine over what temporal and spatial scales these optical properties are conservative. To use optical properties of CDOM to identify component species of DOM in situ in coastal regions.

APPROACH

In the past 20 years, deployments of bio-optical instrumentation have provided a wealth of information pertaining to interaction between physical processes and distribution of phytoplankton cells (Denman and Powell 1984), including demonstrations of extremely small-scale structures (Cowles et al. 1993). We propose to expand the use of optical measurements for elucidation of physical mixing processes by including CDOM fluorescence, which behaves conservatively in most coastal regions over a wide range of salinities.

Measurements of inherent optical properties of colored dissolved organic matter (CDOM), including fluorescence efficiency, will be made both in situ and on discrete samples to identify and measure characteristic CDOM species at the Coastal Mixing and Optics study site in the North Atlantic Ocean. Simultaneous in situ measurement of phytoplankton pigments will be used to assess the degree of covariation between dissolved and particulate optical signals and to describe conditions responsible for observed distributions.

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE **30 SEP 1997**	2. REPORT TYPE	3. DATES COVERED **00-00-1997 to 00-00-1997**

4. TITLE AND SUBTITLE **Measurement and Characterization of Gelbstoff Optical Properties as a Water Mass Tracer in Coastal Regions**	5a. CONTRACT NUMBER
	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **University of South Florida,Department of Marine Science,140 7th Avenue South,St. Petersburg,FL,33701**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT **unclassified**	b. ABSTRACT **unclassified**	c. THIS PAGE **unclassified**	**Same as Report (SAR)**	**3**	

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std Z39-18

WORK COMPLETED

The second field experiment was successfully completed during April to May 1997. Approximately 100 continuous profiles of DOM fluorescence using two different instruments were obtained and discrete samples were collected on nearly 115 depth casts. The data from this year's field experiment were collected in the same manner as the prior year. A Sea Tech DOM fluorometer (Ex/Em @320/420 nm, 40 nm b.p.) was used to collect profiles on the CTD package. A WetLabs SAFIre (Spectral Absorption and Fluorescence Instrument) was deployed on the CTD-rosette frame integrated with 3 AC-9s and an FSI CTD via a WetLabs super MODAPS (Roesler).

RESULTS

Gelbstoff concentrations were in the range of 0.5 - 2.0 ppb quinine sulfate equivalents (QSE) for both cruises, with small but discernible seasonal and spatial differences. Highest concentrations were observed in the bottom water layer, where CDOM varied positively with salinity during both seasons. Fluorescence 'fingerprints' indicate that biological production supplies some CDOM during both Fall and Spring, but the dominant process at the surface appears to be photodegradation.

Seasonal differences include: (1) surface CDOM concentrations were 2-3 times higher in Spring, (2) correlation between CDOM and chlorophyll concentration was observed only during the Fall, and (3) a slight near bottom elevation in CDOM was observed in some profiles taken during the Fall cruise. Preliminary comparisons between the two seasons indicate that the factors controlling gelbstoff concentrations during Spring are more related to physical circulation, with fresher water influx supplying CDOM to the study site and a negative CDOM-salinity relationship at the surface. During Fall, biological productivity was more important in surface waters than freshwater input. The relationship between CDOM and salinity in the bottom water was positive during both seasons, indicating that deep waters off the shelf are a secondary source of gelbstoff in the region. These results will be presented at the 1998 Ocean Sciences meeting in San Diego, CA (Conmy and Coble, 1997).

IMPACT/APPLICATION

In situ multispectral measurements of fluorescence, absorption, and scatter at wavelengths below 400 nm are novel and will provide new data relating to organic matter in the ocean. The density of our profiles and the completeness of data provided by collaborators will allow optical characteristics of dissolved organic matter to be interpreted as the direct result of physical and biological processes.

RELATED PROJECTS

1-I have agreed to a collaboration and intercomparision of data with Collin Roessler (UCONN) and her ONR-sponsored post-doctoral student Anne Petrenko, who will take the lead in merging optical results with physical results.

2-I am also using data from the CM&O study to enhance my NASA-funded collaboration in NRL's Spectral Signatures Program. Data from the Chesapeake Bay outflow region have already been collected during two seasons, and an additional field program in the Gulf of Mexico will provide data from a third coastal ocean area for comparision of in situ optical properties of colored dissolved organic matter. Collaborators include Steve Lohrenz (USM), Alan Wiedemann (NRL) and Curt Davis (NRL).

REFERENCES

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